## XIV. "Notes of Researches on the Intimate Structure of the Brain."—Second Series. By J. Lockhart Clarke, Esq., F.R.S. Received June 20, 1861.

In consequence of the frequent interruptions to which I am necessarily exposed in the course of my anatomical investigations, I beg to communicate to the Royal Society, in the form of notes, some of the results at which I have arrived, with a promise to forward, in a few months, a complete memoir on the same subject, with the necessary illustrations.

In my memoir of the "Medulla Oblongata," it is shown that the post-pyramidal ganglion, or grey substance of the posterior pyramid, is developed from the posterior grey substance on each side of the posterior median fissure. At the point of the calamus scriptorius, it is intimately connected with the pyriform nucleus of the vagus nerve, each receiving a process from the other. Between these two, and apparently developed from the substance of both, which are intimately blended with it, there arises a convex and somewhat triangular mass, which becomes the principal nucleus of the auditory nerve. In a transverse section it is triangular, one of its angles projecting forwards into the root of the caput cornu posterioris, or expanded extremity of the posterior horn. It is interspersed with numerous large nerve-cells, which are round, oval, triangular, or otherwise irregular, and of considerable size, the largest measuring the 800th of an inch in diameter. Another portion of the auditory nucleus is in contact with the outer side of that just described, and with the inner side of the restiform body. It consists of the outer part of the posterior pyramid in the form of a remarkable network, enclosing in its meshes longitudinal fasciculi, and containing large nerve-cells with branched and exceedingly long processes, which contribute to form the network. From both these parts of the nucleus the posterior division of the auditory nerve takes its origin, and winds outward as a broad convex band over the restiform body. In this course it contains, at first, a few small cells, elongated in the direction of its fibres; but as it proceeds, its cells become gradually larger and more numerous, until at the anterior border of the restiform body it enlarges into a pyriform ganglion, which is crowded

with nerve-cells similar in appearance to those of the inner nucleus. The nerve is also reinforced by fibres radiating from the centre of the restiform body as it winds round the latter. The *anterior* division of the auditory nerve consists of two portions: the principal portion penetrates the medulla beneath the restiform body, and, running along the outer side of the caput cornu, enters both parts of the auditory nucleus; the other portion runs backward along the upper border of the restiform body, which it accompanies over the superior peduncle to the inferior vermiform process of the cerebellum. The outer portion of the auditory nucleus, consisting of the posterior pyramid and its vesicular network, is also ultimately thrown backward into the cerebellum, part of it arching over the fourth ventricle to the opposite side, while the rest extend outward to the corpus dentatum. The corpus dentatum is grasped, as it were, by an expansion of the restiform body, which bends backward after entering the cerebellum.

It would be useless in this place to attempt an intelligible description of the complicated course of the fibres in the human pons Varolii; but I may observe, that at its lower portion I find a structure in every sense homologous with that which in Mammalia is called the *trapezium*. It is not, however, situated *below*, but *within* the *pons*, of which it forms the most posterior of the transverse fibres. These transverse or arciform fibres proceed out of the restiform bodies and auditory ganglia, and sweep round the extremity of the caput cornu to the back of the anterior pyramids to decussate across the raphe. As they pass the ganglion, or auditory nerve, they receive fibres from it. On each side, where, in animals, it forms a rounded projection, it contains a very peculiar vesicular nucleus, which has a convoluted appearance and structure, resembling another olivary body. These nuclei, which were first pointed out by myself in 1857 (Proceedings of Royal Society), and subsequently by Prof. Schröder V. der Kolk, first make their appearance much lower down in the medulla, at the point where the other olivary bodies begin to diminish, as two cylindrical columns of large nerve-cells with bundles of longitudinal fibres. On reaching the *trapezium*, the cells become much smaller, and are arranged in convoluted laminæ. They are larger in animals than in Man, and are particularly developed in the Cat. Through the trapezium the facial nerve passes transversely backward and

inward beneath the root of the trifacial nerve and the caput cornu, to a group of large multipolar cells, which lies near the surface of the fourth ventricle, on each side of the median furrow, and which gives origin also to the sixth nerve.

The transverse fibres of the pons Varolii are an extension of the arciform fibres of the medulla oblongata. The grey substance of the pons is arranged in a peculiar manner. Its cells are generally round, oval, and fusiform, of about the 1500th of an inch in diameter, and are so connected with nerve-fibres, in chains or bundles, as to form a complete network. The principal chains of this network have, in general, a longitudinal extension, and follow the course of the longitudinal fasciculi of the anterior pyramids, from the sides of which they send off processes across the transverse bundles, in which, as well as around the longitudinal bundles of the pyramids, the cells are at intervals collected into groups of variable size and shape.

The trifacial or fifth nerve originates from a somewhat conical eminence of grey substance, which is situate immediately behind the fossa where the anterior fibres of the pons Varolii meet the point of the fillet, at the upper edge of the middle peduncle of the cerebellum. This grey mass consists of three distinct nuclei in close apposition. Its outer portion is the caput cornu posterioris, or dilated extremity of the posterior cornu, and is composed of several groups of small round and oval cells, of about the 1500th of an inch in diameter, together with numerous longitudinal bundles of nerve-fibres. The posterior portion of the grey mass overlies, and is continuous with, the root of the caput cornu. It is the upward extension of the inner nucleus of the auditory nerve, and contains many cells of a larger kind. The inner side of the mass consists of an oval group of large multipolar cells of the same shape and size as those of the anterior cornu of the medulla spinalis. The large root of the fifth nerve may be divided into three parts, two of which originate in the conical mass just described; of these two, the larger arises from the caput cornu posterioris, while the fibres of the smaller may be traced backward to the continuation of the auditory ganglion, which overlies the cornu. These latter are probably the fibres which go to form the gustatory branch of the fifth nerve; for it was formerly shown that the commencement or lowest part of the auditory ganglion was the principal origin of the glosso-pharyngeal nerve. The third

division of the large root of the fifth descends towards the medulla, not, as has been believed, in the restiform body, but, as I formerly showed, in the very substance of the caput cornu posterioris, of which it constitutes many of the longitudinal bundles.

The small, or motor root of the fifth arises from the same eminence by three or four parallel bundles, a little anterior to the larger root, being separated from it only by a small process of the middle peduncle coming from the upper portion of the pons Varolii. Its bundles pass obliquely to the inner side of the caput cornu, and spread out their fibres through the oval group of large multipolar cells already mentioned. Some of the fibres of the fifth nerve decussate with those of the opposite side through the raphe.

Some of the fibres which form the point of the fillet, as well as others coming from the anterior border of the pons Varolii, are connected with the grey eminence of the fifth nerve.

In tracing the caput cornu towards the brain, it is found to extend obliquely outwards from the angle in the floor of the fourth ventricle, beneath the superior peduncle: the deep portion of the superior peduncle, before it reaches the corpora quadrigemina, passes from the side of the fillet transversely inwards in front of the caput cornu to the middle line, where it decussates with the corresponding part of the opposite side. Part of the grey substance of the caput cornu becomes imbedded in the fibres of the fillet, and ascends with them; while the rest extends more and more backward along the under part of the superior peduncle, until it arrives at its inner border at the side of the valve of Vieussens. Across the thin posterior edge of the superior peduncle it sends numerous grey processes outwards, to meet similar processes from the grey substance in the fillet; so that the longitudinal fibres of this part of the peduncle are formed into small bundles by a network of grey substance; the testis, or posterior portion of the corpora quadrigemina, on each side, rests upon this structure: it is continuous with, and apparently developed from it.

While these changes are in progress, the nucleus of the motor root of the fifth nerve gradually disappears, and is replaced by a group of cells deeply coloured with pigment, and constituting what is known as the *substantia ferruginea*; at the same time the grey substance which forms the floor of the fourth ventricle on each side

of the median furrow increases gradually in depth, and includes the *substantia ferruginea*. It is developed in the tract which is continuous with the nucleus of the hypoglossal nerve, of which it is the analogue. Anteriorly, on each side of the raphe, there is gradually developed within it a considerable group of large multipolar cells, which becomes the nucleus of the third cerebral nerve. At its outer and back part it adjoins the tract which forms the side wall of the ventricle, is continuous with the auditory nucleus, and lies at the base of the caput cornu posterioris. This latter tract, on reaching the corpora quadrigemina, becomes continuous with its fellow of the opposite side to form the roof of the iter a tertio ad quartum ventriculum. Here it becomes gradually broader and more transparent, and, in the form of an arched lamina, supports the lateral lobes of the corpora quadrigemina, with which, at its border, it is intimately *blended*, and which communicate over it by a transverse band of fibres. It contains a multitude of small cells of various shape and size, and is interlaced in every direction by very fine nerve-fibres; but of the latter there are two regular sets, which run longitudinally and transversely, and which increase in number from behind forwards, so that they are much more numerous beneath the nates; the transverse fibres radiate in straight lines towards the surface through the lobes of the corpora quadrigemina.

*Structure of the Corpora Quadrigemina.*—The lateral lobe of each testis is an oval or almond-shaped mass, which rests on the convexity of the transparent arch just described. It contains a considerable number of small and uniformly scattered cells of various shapes, and of an average size of about the 2400th of an inch, together with oblique, transverse, and longitudinal nerve-fibres; the longitudinal fibres form a denser layer at its inner and still more at its outer side. The transverse fibres form two sets, one extending over the arched lamina to the opposite lobe, and derived chiefly from the fillet; the other radiating, as already stated, from the substance of this lamina beneath, towards the surface, and becoming continuous, at least in part, with the first set, as well as with the longitudinal.

The structure of the nates is, in general, similar to that of the testes: their cells are nearly of the same nature, but smaller; their lobes are shallower, but longer; and the arched transparent lamina on which they rest is broader and more transparent. Both the trans-

verse and longitudinal fibres are much more numerous. Those which extend transversely from *side to side* decussate in the middle line, and, through the under half of the lobes, form a dense layer of separate bundles; between these bundles, and at right angles to them, the other set of transverse fibres radiate from the arched transparent substance beneath, and after penetrating to various depths, turn round to become continuous partly with them and partly with the longitudinal fibres which run chiefly along the superficial half of the lobes. The same system of latero-transverse bundles is continued in front of the nates to form the posterior commissure. A large proportion of the optic nerve is connected with the nates. The optic tract, on reaching the back of the thalamus opticus, divides into two parts: one of these, after bending suddenly downwards and somewhat inwards, enters the corresponding lobe of the nates, spreading amongst its cells, and forming its longitudinal as well as some of its transverse fibres; the other division of the optic tract winds inwards and somewhat backwards over the thalamus, which it enters, diverging, between streaks of longitudinal fasciculi, in a series of separate bundles, which, in their turn, diverge and distribute their fibres in every direction amongst a dense collection of cells. The cells are various in size and shape; a considerable proportion are round, oval, or fusiform in the direction of the bundles which first enter. Some of the fibres of the optic tract are connected with the *corpus geniculatum internum*, which is crowded with cells of a medium or rather small size, and for the most part round or oval.

*Structure of the Pineal Gland.*—The structure and relations of this body are of great interest, and deserve close attention. It is attached by its base to the posterior commissure. The arched transparent lamina which forms the roof of the canal, or iter, beneath the corpora quadrigemina, decreases in thickness or depth as it approaches the anterior extremity of the canal, beyond which it is reduced to the epithelial layer which lined it. This epithelium is now reflected round the front of the posterior commissure, and from thence under the base of the pineal gland. When carefully examined, it is found, along its border, to be composed of narrow fusiform cells, intermixed with round and oval granular nuclei, of which the average diameter is about the 2800th of an inch. From both kinds of these cells or nuclei fibres proceed and cross each other in every

direction; so that they form a considerable layer around the commissure, through which, by numerous fissures, they radiate to its opposite surface. This fibrous and inner layer is crowded with round and oval nuclei like those found at the border. Now when the epithelium is followed to the pineal gland, the substance of the latter is seen to be composed of elements which resemble it so closely, and are so uninterruptedly continuous with it, that one can scarcely question the probability that the two kinds of structures are only slight modifications of each other. The pineal gland consists of fibres, nuclei, and the well-known brain-sand. The fibres are arranged in two ways; throughout the gland they form, by peculiar subdivisions and communications, an intricate network, in which the nuclei are lodged. Some of them are exceedingly fine, others rather coarse, but bear no resemblance to what we are accustomed to call nerve-fibres. They are frequently crooked, and apparently jointed or dilated at intervals, where they give off branches which bear nuclei; in other places the nuclei are surrounded by flat riband-like fibres. Here and there the fibres of the network go off to form straight bundles, which unite into larger trunks, and have chiefly a transverse direction. The reticular structure bears a decided resemblance to the epithelium of the olfactory mucous membrane, and still more to what I have elsewhere described as the fourth layer of the olfactory bulb in the Sheep, and particularly in the Cat.

In the pons Varolii the decussation between fibres from the opposite sides is extremely complicated. In a direction from behind forwards there is a series of decussations:—1. Between fibres of the superior peduncles of the cerebellum; 2. Between some of the inner fibres of the fillet as they descend obliquely to the medulla oblongata; 3. Between fibres proceeding from the corpora quadrigemina behind the crura cerebri; 4. Between fibres proceeding from the floor of the iter a tertio ad quartum ventriculum and the nucleus of the third nerve; and, 5, Between numerous fibres of the crura cerebri, as they enter the upper end of the pons Varolii.

In the substance of the pons Varolii, and resting on the outer and back part of the cylinder formed by the superior peduncle on each side, there is a short but thick cylindrical column of large multipolar cells, pierced by a number of longitudinal bundles, and connected by fibres with the nucleus of the third nerve. It commences

a little below the origin of the third nerve, fibres of which pass directly through it; but I am at present uncertain whether any of them originate from its cells. It is much more distinct in some animals than in Man.

The corpora albicantia are ganglionic masses containing a multitude of cells, which are mostly round, oval, pyriform, fusiform, triangular, and quadrangular, and lie amongst the winding fibres of the anterior pillars of the fornix. These cells vary considerably in size, but are generally small; the diameter of the largest of the spherical kind being about the 2000th of an inch. The two bodies are united across the middle line by a transverse commissure of fibres containing cells which are fusiform in the same direction.

Except when stated to the contrary, the above notes refer exclusively to the structure of the *human* brain.

XV. "On the Influence of Atmospheric Pressure upon some of the Phenomena of Combustion." By Dr. Edward Frankland, F.R.S. Received June 20, 1861.

(Abstract.)

The author has concluded his experiments upon this subject; and, in addition to the details of the results which have already been briefly mentioned in the 'Proceedings of the Royal Society'*, communicates the following:—

Although *the rate of burning* of candles and other similar combustibles, whose flames depend upon the volatilization and ignition of combustible matter in contact with atmospheric air, is not perceptibly affected by the pressure of the supporting medium, yet this is not true of all combustibles. The rate of burning of self-supporting combustibles, like the time-fuses of shells, depends essentially upon the pressure of the medium in which they are deflagrated. Attention was first called to this fact by Quartermaster Mitchell†, who found that the fuses of shells burnt longer at elevated stations than when ignited near the level of the sea. The results of the

* Proceed. Royal Soc. vol. xi. p. 137.

† Ibid. vol. vii. p. 316.